CALIFORNIA FOREST AND RANGE
EXPERIMENT STATION

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

THE SAN DIMAS EXPERIMENTAL FOREST

Glendora, California

California Forest and Range Experiment Station
S. N. Wyckoff, Director
Maintained at Berkeley, California in cooperation with the
University of California

FOREWORD

The San Dimas Experimental Forest is a 17,000 acre watershed-research laboratory situated in the San Gabriel Mountains of southern California. Here the U. S. Forest Service and the State of California in cooperation are studying rainfall, soil water movement, streamflow, and erosion in relation to watershed vegetation, soils, geology, and topography. This research program is planned to develop the principles and practices of management for chaparral-covered watersheds. The goal of such management is the maximum production of usable water combined with the minimum danger of floods and erosion.

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Forest Watershed Areas

Watershed	Drainage area Square miles	Drainage area Acres	Range in elevation
	MAJOR		
San Dimas	15.75	10,080	1500-5500
Big Dalton	4.46	2,855	1700-3500
	INTERMEDIATE		
San Dimas			
I Wolfskill	2.39	1,530	1700-5200
II Fern	2.14	1,370	2600-5500
III Upper East Fork	2.14	1,370	2600-5200
IV East Fork	5.48	3,510	1900-5500
V North Fork	4.23	2,710	1900-4500
VI Main Fork	13.14	8,410	1600-5500
VII West Fork	1.72	1,100	1600-3100
Total XII (San Dimas)	15.75	10,080	
Dalton			
VIII Bell	1.36	870	1900-3500
IX Volfe	1.16	740	1900-3500
X Monroe	1.37	875	1800-3400
Total XI (Dalton)	4.46	2,855	
	SMALL		
Bell			
No. 1	0.121	77	2500-3400
No. 2	0.158	100	2500-3500
No. 3	0.097	62	2500-3400
No. 4	0.058	37	2500-3100
Total	0.434	276	
Fern			
No. 1	0.055	35	4500-5400
No. 2	0.063	40	4500-5400
No. 3	0.084	53	4500-5400
Total	0.202	128	

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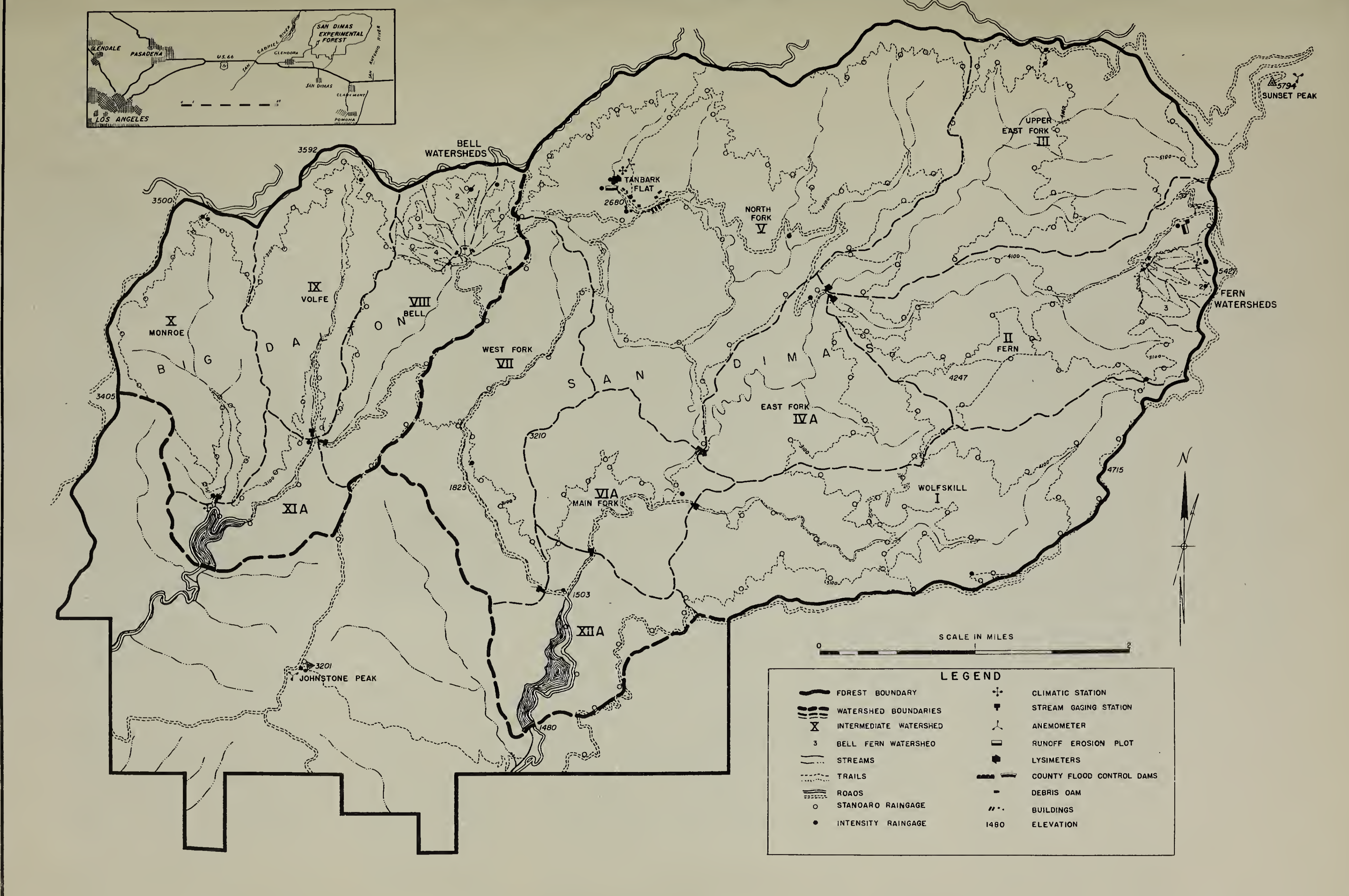

THE SAN DIMAS EXPERIMENTAL FOREST

By E. L. Hamilton

An adequate water supply is probably the most important factor affecting the future growth or even the existence of the great agricultural, industrial, and metropolitan development of southern California. The inhabitants of the Pueblo of Nuestra Senora la Reina de los Angeles de Porciuncla, or more simply, Los Angeles, dipped their supply of water from a shallow ditch running through the plaza. Agricultural practice as carried on then chiefly by the missions was largely dependent upon irrigation water derived from a few live streams and from cienagas or springs whose sources were the chaparral-covered mountains to the northeast.

During succeeding decades, California developed rapidly. Gold was discovered in the north, railroads were built, oil wells were drilled, and people continued to flock into the State. The influx of settlers into southern California in the last 60 years has caused a metropolitan expansion almost unprecedented in history, and the agricultural resources of the land were developed accordingly. This growth brought about ever increasing demands for water.

Early needs for greater supplies were met by the digging of shallow wells, some of which produced artesian flows, and by the building of small storage reservoirs in the foothills. Later it became necessary to sink deeper wells to reach water tables lowered by the increased draft upon them. Wells which used to supply water from depths of from 20 to 40 feet, now have been sunk over 300 feet and powerful pumps are required to bring the water to the surface. These wells are drilled in the alluvial fans extending from the mountains far out into the valleys. The alluvial deposits which form the valley floors are underlain by impervious rock and are bounded on the south by natural rock dikes, thus forming enormous underground reservoirs which are replenished by water from the mountains to the north.

The acuteness of the water problem, emphasized by periods of low rainfall and continued metropolitan growth, led to the importation of water into southern California from distant areas through the long tentacles of the Owens Valley aqueduct to the north and the Metropolitan aqueduct to the east. These developments made at tremendous cost to bring life-giving water over mountain ranges and deserts are indicative of its value in a semiarid region where other natural advantages abound.

During the last three decades the draft on most underground reservoirs has been so much greater than the supply to them that increasing attention has been focussed on the mountain watersheds from which these basins are refilled. Most of these watersheds are within national forests which were established for their protection, and which are administered by the Forest Service of the U. S. Department of Agriculture. Preliminary studies of the condition of the mountain areas in relation to water yield from them were started by the Forest Service more than 35 years ago. These studies were continued in 1927 by the California Forest and Range Experiment Station, and in 1933 this research agency of the Forest Service began a comprehensive inquiry into the problems of water supply and flood control with the active cooperation of state and municipal agencies, conservation groups, engineers, and agriculturists.

The area selected for the investigations includes Big Dalton and San Dimas Canyons, which are situated in the San Gabriel Mountains within the Angeles National Forest several miles northeast of the city of Glendora. This area has been named the San Dimas Experimental Forest. It is, in effect, an extensive outdoor laboratory where studies of rainfall, streamflow, erosion, water use by vegetation, and other related phenomena are being carried on to analyze the various phases of the water problem. The basic data obtained are being used to determine methods of watershed management which will insure the maximum flows and yield of usable water with regulation of flood flows from the southern California mountains. This research program comprises (1) the accurate measurement of climatic conditions, particularly the precipitation which falls on the watersheds; (2) determination of the total quantity of water which runs off the area as streamflow; (3) measurement of the erosion which accompanies the runoff; (4) determination of the amount of water used by the chaparral vegetation and transpired into the atmosphere; and (5) evaluation of all factors including geology, soils, and vegetation which may affect any of the foregoing phenomena.

As mentioned before, the experimental forest includes an area of about 20 square miles in Dalton and San Dimas Canyons. A concrete dam has been built by the Los Angeles County Flood Control District near the mouth of each of these drainages, primarily for flood control and, to a lesser degree, for the storage of irrigation water. Records of total streamflow from each watershed are obtained from inflow measurements at the dams, and total erosion is obtained by annual surveys of the reservoirs themselves. The major drainages have been subdivided into their component canyons which are termed "intermediate watersheds." They are 10 in number, and range from 750 to 8,576 acres in area. A stream gaging station has been built at the mouth of each in order to measure the runoff from the respective areas. These stations are built of concrete, and are of varying sizes. They consist of three units--a triangular 90 degree V-notch weir used to measure normal clear water flows up to 6½ cubic feet per second; a steel San Dimas type flume to record ordinary silt-laden storm flows up to 80 to 100 cubic feet per second; and a large concrete flume whose function is to record high flood flows which may reach the amount of 600 to 4,000 cubic feet per second.

The rainfall measurement program on the San Dimas Experimental Forest was originally set up with a network of 310 rain gages. Supplementary studies were made to determine suspected errors in the rainfall sampling system. The nature and cause of the errors were determined, and an improved method of sampling was devised. Additional studies were designed to determine the characteristics of delivery of rainfall to the watersheds. These data are to be used in correcting errors in previously collected rainfall data. During the interim period of study the original network of 310 rain gages was increased to 434. Supplementary studies indicated that rain gages, tilted and oriented according to watershed slopes, gave more accurate samples of rainfall than the original network; hence it was decided to adopt tilted gages. The old sampling system was discontinued as of October 1, 1950, and a network of tilted gages which has been under observation for 3 years, was adopted for future use. These gages totaled 120, of which 35 are in the Bell and Fern small watersheds, and 85 are forest-wide. Fifteen of the gages are automatic instruments which record directly the amount and intensity of the rainfall.

The four Bell Multiple watersheds, which vary in size from 37 to 101 acres, are located in the upper reaches of Big Dalton Canyon within an altitudinal range of 2,500 to 3,400 feet. Here observations are made with a degree of refinement which is not possible on the larger areas. The behavior

of these small watersheds is being observed for a period of years, and after their inherent characteristics have been determined some of them will be subjected to manipulation, such as changing the character of the chaparral cover. As the measurements are continued, the treated areas will be compared with those left in a natural condition. Similar research is being conducted on the Fern Multiple watersheds, three in number, totaling 128 acres in area and located in the headwaters of San Dimas Canyon. Precipitation at that elevation, 4,500 to 5,400, is partly in the form of snow. Here the vegetation had been unburned for over 50 years prior to November 1938, when a brush fire originating in San Antonio Canyon to the northeast swept over this area. What appeared at first to be a calamity proved later to be a form of treatment which could never have been obtained under controlled conditions, and a comparison of the measurements before and after the fire have been of great value in the study of watershed reactions.

Further detailed runoff and erosion studies are being made on small 1/40th acre plots. Twenty-two of these plots have been established in three different altitudinal vegetation-type zones. Here the runoff from plane soil surfaces, as differentiated from drainage areas, is recorded synchronously with the rainfall on automatic instruments. Provision is also made to catch and measure the total erosion from these areas. A set of plots close to the Fern watersheds was burned over by the fire of 1938 which denuded the latter. Again the comparative measurements of runoff and soil movement before and after the vegetation was destroyed have been of great value.

The difficult problem of determining the amount of water used by chaparral vegetation is being attacked by the use of lysimeters, which are in effect tanks filled with soil in which the species to be studied are grown. Precise measurements are made of the precipitation falling on these tanks, the runoff and evaporation from their surface, and the percolation of water down through their soil mass. The San Dimas lysimeter installation located on the Forest at Tanbark Flat is probably the largest and most complete of its kind in existence. The series consists of 26 large concrete units, each 10.5 x 21 feet in surface area and 6 feet deep, augmented by more than 100 smaller metal tanks. These tanks are filled with a uniform mixture of local soil, and were planted with several chaparral species after an initial period of soil settling and observation. The results from the metal and concrete tanks will be checked against five unconfined lysimeters which are merely holes in the ground 17½ feet square and 7 feet deep which are filled with the same uniformly mixed soil as the other lysimeters and are planted with the same vegetation. Records of water loss from the small and medium iron tank lysimeters are obtained by actually weighing them. Volumetric measurements of the water yield from the large lysimeters are made by catching the runoff and seepage in large tanks set in a concrete tunnel. A number of tanks are equipped with electric water level transmitters which permit the rates of rainfall, runoff, and seepage to be recorded directly on clock-driven charts.

The study of rainfall, streamflow, and water use by vegetation requires supplementary information in the form of meteorological observations. These data have been collected at seven stations distributed throughout the forest at altitudinal ranges of 1,500, 2,800, 4,350, 5,100, and 5,200 feet. Continuous records of air temperature, relative humidity, wind direction and velocity, evaporation, soil temperature, barometric pressure, and precipitation intensity are obtained from several instruments located at each station. The master station is located at Tanbark Flat and is much more complete than the others.

Detailed studies of the vegetation, fauna, geology, and soil are under way to complete the picture of environmental influences. Much of this work is centered at the field headquarters of the Experimental Forest which is located at Tanbark Flat 12 miles north of Glendora. Here are maintained a laboratory, shops, garages, warehouses, and quarters for technical assistants and guests. Barracks and mess halls are provided for a 150-man labor camp.

Research in the field of the influence of forests on human benefits, among which may be stressed the regulation and production of usable water, is necessarily slow. Records have been taken over a period of 18 years. Techniques have been improved and plans revised, and gradually a valuable mass of detailed information already sought after by engineers, foresters, and others, is being accumulated to round out the history of the drop of water from the time of its impact on the earth until it passes into the conduits of distribution.

ANNOTATED BIBLIOGRAPHY OF PUBLICATIONS ON PHASES OF WATERSHED MANAGEMENT RESEARCH ON THE SAN DIMAS EXPERIMENTAL FOREST

September 30, 1951

General

The San Dimas Experimental Forest, San Dimas Staff.
Illustrated booklet outlining objectives and describing experimental installations. 19 pp.

The San Dimas Experimental Forest, C. J. Kraebel and J. D. Sinclair. 1940. Amer. Geophys. Union Trans. Pt. I, pp. 84-92.
Descriptive article illustrating experimental installations and giving general summaries of results during six years of operation.

\# The San Dimas Experimental Forest. E. L. Hamilton. Oct. 1940. Social Studies Review, 16:5, pp. 10, 12-14; also mimeographed.
Narrative statement of the water problem in southern California and a brief description of experimental installations.

Precipitation

An Analysis of Precipitation Measurements on Mountain Watersheds, H. G. Wilm, A. Z. Nelson, and H. C. Storey. June 1939. Monthly Weather Review, Vol. 67, pp. 163-172.
Analysis was made of precipitation measurements from gage systems on mountainous watersheds to determine reliability of computed rainfall averages and to decide if the original gage distribution provided accurate sampling of the watershed rain catch. The requirements for accuracy of averages were modified in inverse relation to size and importance of storms. A simple average of well-distributed gage readings will agree within close limits with rain catch computed from isohyetal maps.

Topographic Influences on Precipitation, H. C. Storey. 1939. Proceedings Sixth Pacific Science Congress at Berkeley, California, Vol. 4. July 1941. Soil Resources, pp. 985-993.
Isohyetal maps show distribution of annual precipitation successively State-wide, then over Los Angeles County, and finally in detail on the San Dimas Experimental Forest. Variations in precipitation are explained by reference to topographic influences.

A Comparative Study of Rain Gages, H. C. Storey and E. L. Hamilton. 1943. Amer. Geophys. Union Trans. Pt. I, pp. 133-141.
Rainfall was caught in several types of rain gages placed on hillsides exposed in three different directions. Gage catches were compared with the catch of rain on adjacent large concrete surfaces laid parallel to and at ground level. Standard rain gage catch was found to be significantly closer to that of the ground surface if the gage was tilted normal to that surface rather than being exposed vertically.

#-Publications marked with (#) were available for distribution on September 30, 1951.

Rainfall Measurement as Influenced by Storm Characteristics in Southern California Mountains, E. L. Hamilton. 1944. Amer. Geophys. Union Trans. Pt. III, pp. 502-518.

Preliminary records indicated the need for supplementary research on rainfall characteristics and storm behavior. From observations of 173 storms which produced 251 inches of rain over a 7-year period, a representative sample of 60 storms was subjected to detailed study. Records from a novel instrument, a "vectopluviometer" or directional rotating rain gage, permitted the development of directional storm patterns and computation of the angle of inclination of rainfall from the vertical which could be correlated with wind velocity and rainfall intensity. The study indicated that southern California storms follow definite patterns which can readily be classified into groups having definite characteristics. The interpretation of these group characteristics is necessary to determine the proper distribution and exposure of rain gages on mountain watersheds to insure the accurate measurement of precipitation.

A Comparison of Vertical and Tilted Rain Gages in Estimating Precipitation on Mountain Watersheds, H. C. Storey and H. G. Wilm. 1944. Amer. Geophys. Union Trans. Pt. IV, pp. 518-523.

Precipitation on a 100-acre watershed within the San Dimas Experimental Forest was measured with a network of rain gages at 22 sites. The gages were paired at each location, one being installed vertically and the other tilted normal to the slope. Analysis of a 4-year record showed that the better measure of total rainfall on this steep mountainous watershed was obtained by the use of the tilted gages.

A System for the Synchronization of Hydrologic Records, E. L. Hamilton. 1943. Amer. Geophys. Union Trans. Pt. II, pp. 624-631.

Describes how recording instrument charts on the San Dimas Experimental Forest are kept chronologically in step with each other by electrical time impulses sent hourly by a clock at the Tanbark Flat Field Headquarters. Several widely distributed tipping-bucket rain gages also record synchronously by sending electric impulses over similar circuits to a central laboratory where, after amplification through relays, rainfall increments of 0.02 inch are recorded on a strip chart having a separate space for each gage.

The San Dimas Tipping Bucket Rain Gage Mechanism, E. L. Hamilton. February 1947. Amer. Met. Soc. Bull. 23:2, pp. 93-95.

Description of an inexpensive mechanism for the measurement of rainfall intensities. The unit can be installed in a standard 8-inch rain gage and the rainfall rates transmitted electrically to a suitable recorder. Featured are frictionless and non-corrodible electrical contacts.

The Problem of Sampling Rainfall in Mountainous Areas, E. L. Hamilton. 1949. Proceedings of the Berkeley Symposium on Mathematical Statistics and Probability. pp. 469-475. University of California Press.

On the San Dimas Experimental Forest in southern California an extensive distribution of 200 rain gages was made to determine variations in amount of rainfall on different slopes and at different altitudes in connection with watershed management research. Preliminary analyses indicated that although the arrangement of the sampling units was adequate, the technique of measuring rainfall might be subject to question. A device called the "equivalent facet" was selected as the basis for revising the rainfall-sampling network. In this system the placement of the rain gages was adapted to the terrain on an areal basis.

Rainfall Interception by Chaparral in California, E. L. Hamilton and P. B. Rowe. California Dept. Natural Resources, Div. of Forestry. 1949. 43 pp., 16 illustrations.

Determination of rainfall not reaching the soil, called interception loss, is important in the solution of water supply and flood control problems. Loss of rainfall through interception by shrub type vegetation was measured at three locations in California. On one area in the Sierra Nevada foothills in central California 81 percent of an average annual rainfall of 42 inches reached the soil as fall through and drip from the brush cover, 14 percent reached the soil as flow down the stems, and 5 percent was lost before reaching the soil as direct evaporation from the vegetation. On another area in the same vicinity with a different type of brush cover, 62 percent of an average annual rainfall of 38 inches reached the soil as throughfall, 30 percent as stemflow, and 8 percent was lost by interception. In the San Gabriel mountains of southern California, 81 percent of an average annual rainfall of 22 inches reached the soil as throughfall, 8 percent as stemflow, and 11 percent was lost by interception. Amounts of throughfall, stemflow, and interception loss varied directly with storm size. However, the proportion of interception loss varied inversely with storm size. An equation of interception loss for storms of more than 0.3 inch is given for each study area. The interception process through the course of characteristic storms is discussed.

San Dimas Rainfall and Wind Velocity Recorder, E. L. Hamilton and L. A. Andrews. 1951. Amer. Met. Soc. Bull. 32:1, pp. 32-33.

A vertical drum waterstage recorder was modified for operation with an electromagnetically operated pen. It is suitable for recording electrical impulses induced by tipping bucket rain gages or anemometers. The recorder will run for 8 days, and 75 lineal feet of impulses can easily be recorded on a 12 x 18 inch standard chart at a speed of 4-1/2 inches an hour.

Streamflow

Measurement of Debris-Laden Streamflow with Critical-Depth Flumes, H. G. Wilm, John S. Cotton, and H. C. Storey. September 1938. Amer. Soc. Civ. Engrs. Trans. 103:9, pp. 1237-1278.

Field experiments were conducted for the purpose of adapting existing gaging stations to measurement of loaded flows. Several types of flumes were tested including a modification of the Parshall flume, trapezoidal flumes, and rectangular flumes with sloping floors. Following these experiments, a control flume of the third type was developed functioning as a broad crested weir in which water depths are measured at a point downstream of the "critical" section. Supercritical water velocities kept the flume scoured clean, and it thus could be rated to give greater accuracy of loaded streamflow than other existing devices.

Velocity-Head Rod Calibrated for Measuring Streamflow, H. G. Wilm, and H. C. Storey. November 1944. Civ. Eng., 14:11, pp. 475-476.

The measuring stick described was developed to facilitate the gaging of (small volumes of) streamflow containing varying amounts of bed load and silt where standard measuring gages are not provided. It can be used even when the water carries considerable amounts of debris.

The San Dimas Waterstage Transmitter, E. A. Colman and E. L. Hamilton. June 1944. Civil Eng. 14:6, pp. 257-258.

Description of water level indicating instrument designed by members of the Experimental Forest staff which has been used successfully on research installations for the measurement of liquid flow.

Instrument Facilitates Setting of Weir Zero Values, Paul B. Johnson and Herbert C. Storey. November 1948. Civil Eng. 18:11, pp. 41-42.

The instrument described in this paper was designed for rapid and easy determination of the zero value on 90-degree V-notch weirs. A similar instrument could be used for weirs of different angles. It is simple to make, rugged, highly accurate, and requires little skill to use.

Geology

Geology of the San Gabriel Mountains, California and Its Relation to Water Distribution, H. C. Storey. California Dept. Natural Resources, Div. of Forestry. 1948. 19 pp., 8 illustrations, colored map. (Separate maps available for distribution.)

Description of areal geology, structure, and history of the San Gabriel Mountains. Discussion of the manner in which geology influences the hydrology of a watershed from two viewpoints, (1) effect of land forms on the rainfall pattern, (2) the effect of structural fractures permitting water storage in rock formations, and the faults and dikes that determine the location of streams, springs, and underground basins.

Soils

\# The Dependence of Field Capacity upon the Depth of Wetting of Field Soils, E. A. Colman. July 1944. Soil Sci. 58:1, pp. 43-50.

Irrigation of field plots and subsequent soil moisture sampling is sometimes used to determine the field capacity, which is the maximum amount of moisture the soil can retain against drainage. This paper points out the errors which may arise from such determinations when based upon too shallow depths of penetration of the irrigation water.

\# Some Improvements in Tensiometer Design, E. A. Colman, W. B. Hanawalt, and C. R. Burck. May 1946. Amer. Soc. Agron. Jour. 38:5, pp. 455-458.

Description of a porous clay cup and manometer fittings for use in the study of water movement in the soil. Drawing of instrument.

A Laboratory Study of Lysimeter Drainage under Controlled Soil Moisture Tension, E. A. Colman. November 1946. Soil Sci. Vol. 62, No. 5, pp. 365-382.

A cylindrical column of soil 6 inches in diameter and 6 feet long was irrigated and drained four times, each time with a different moisture tension maintained at or beneath its base. The study showed it is possible to control seepage rate and the drained moisture content of a deep soil column by controlling the moisture tension maintained at the base of the soil.

The Place of Electrical Soil Moisture Meters in Hydrologic Research, E. A. Colman. December 1946. Amer. Geophys. Union Trans. Vol. 27, No. VI, pp. 847-853.

Many kinds of hydrologic research can be facilitated by the use of direct reading electrical soil moisture meters. These meters can be used to measure accretions and losses of soil moisture and the direction and rate of soil-water movement, they can provide a means of controlling the time and amount of irrigation on crop land, and they can discern freezing and melting conditions of water in soil and snow. A meter has been developed by the California Forest and Range Experiment Station to meet these specifications.

\# Manual of Instruction for Use of the Fiberglas Soil-Moisture Instrument, E. A. Colman. October 1947. Revised April 1950. C.F.& R.E.S, Multilithed. 19 pp.

This manual gives a detailed description of the fiberglas and the ohmmeter units of the electrical soil-moisture instrument. The method of installation of the soil units, the method of using the ohmmeters, and the necessary steps in standardizing and calibrating the soil units are fully discussed.

\# A Laboratory Procedure for Determining the Field Capacity of Soils, E. A. Colman. April 1947. Soil Sci. 63:4, pp. 277-283.

It was found that if small soil blocks were drained on a porous ceramic cell under a moisture tension of one-third atmosphere, the moisture retained in the blocks could be related empirically to the field capacity of the same soils determined under natural field conditions. A satisfactory degree of consistency was observed in the relationship between one-third atmosphere moisture percentage and field capacity. It is suggested that the procedure described may provide a convenient and rapid way of making an indirect determination of field capacity. Details of the design of the ceramic cell and moisture tension control equipment are given.

Soil Surveying on Wildlands: The Problem and One Solution, E. A. Colman. 1948. Jour. Forestry. 46:10, pp. 755-762.

Discussion of the difficulties involved in trying to make an intensive soil survey of a mountain watershed on the San Dimas Experimental Forest using the type of survey ordinarily conducted on agricultural lands. Description of a soil survey of the Angeles National Forest planned to classify and map wildland soils on the basis of their hydrologic characteristics.

#, The Fiberglas Electrical Soil-Moisture Instrument, E. A. Colman and T. M. Hendrix. 1949. Soil Sci. 67:6, pp. 425-438.

An instrument devised to measure soil moisture in place consists of a soil unit which includes a monel screen fiberglas cloth sandwich sensitive to soil moisture and a thermistor for temperature detection, and the meter unit which is a battery-powered alternating current ohmmeter. Relationships are indicated for (1) temperature-induced changes in resistance for various soils, (2) freezing and thawing in soils, and (3) moisture tensions. Soil moistures can be measured from pore-space saturation to well below the wilting point.

The Calibration of Fiberglas Soil Moisture Units, T. M. Hendrix and E. A. Colman. 1951 Soil Sci. 71(6): 419-427.

Units calibrated in field soil over a period of 15 months showed no indication of drift in relation between soil moisture content and soil unit resistance. Field and laboratory calibration are in good agreement when laboratory calibration is made in a natural soil core, whereas laboratory calibration made in granulated soil repacked to field apparent density does not agree with field calibration.

Ecology

The Sample Plot as a Method of Quantitative Analysis of Chaparral Vegetation in Southern California, Jerome S. Horton, October 1941. Ecology. 22:4, pp. 457-468.

In order to analyze quantitatively the density of vegetation occurring on a series of small chaparral-covered watersheds, 225 random milacre quadrats were measured. The data were segregated to show vegetative composition. Frequency distributions of vegetative densities were shown to be statistical curves other than normal. Size of plots had no significant influence on the results.

The Wood Rat as an Ecological Factor in Southern California Watersheds, Jerome S. Horton and John T. Wright. July 1944. Ecology. 25:3, pp. 341-351.

The wood rat is one of the most abundant rodents of the chaparral. With the exception of the heavy use of acorns at elevations above 4,500 feet, the feeding habits of this animal do not exert any appreciable influence on chaparral cover because leaf and stem material rather than seeds of the common chaparral shrubs forms the bulk of its diet.

Nomograph Determination of Stem Surface Areas, E. L. Hamilton. January 1949. Jour. Forestry. 47:1, p. 57.

An alignment chart illustrated here cuts out many computations formerly needed for determination of the area of a vegetative stem.

Check-list of the Vertebrate Fauna of the San Dimas Experimental Forest, John T. Wright and Jerome S. Horton. August 1946. CF&RES Mimeographed, 15 pp.

The species comprising the vertebrate fauna of the San Dimas Experimental Forest are listed and very briefly discussed.

Trees and Shrubs for Erosion Control in Southern California Mountains, Jerome S. Horton. 1949. Calif. Dept. Natural Resources, Div. of Forestry. 72 pp.

The problem of erosion control planting in the mountains of southern California is discussed in this bulletin. Fifty-eight species of trees and shrubs are included and their place in erosion control outlined. A section is also included on methods of planting.

Effect of Weed Competition upon Survival of Planted Pine and Chaparral Seedlings, J. S. Horton. June 1950. C.F.& R.E.S. Research Note No. 72.

The effect of competition between annual plants and planted trees and shrubs was studied in 1944 on the San Dimas Experimental Forest in southern California. These plantings were made in an area adjacent to the San Dimas lysimeters to develop the proper method of establishing the desired vegetation. The study has shown that under conditions of summer drought, good survival of planted stock is dependent upon removal (at least during the first season) of competing annual grasses and herbs.

Plant Physiology

A Rapid Method of Separating Seed of Chamise (Adenostoma fasciculatum) from the Duff, E. C. Stone and J. Holt. January 1950. Ecology, Vol. 31, No. 1, p. 149.

In attempting to obtain large quantities of seed from the duff, various methods of separation by screening and floating were unsuccessful. A satisfactory procedure, making use of a small hand-operated "Clipper" seed separator, was worked out.

Water Absorption from the Atmosphere by Plants Growing in Dry Soil, Edward C. Stone, F. W. Went, and C. L. Young. May 19, 1950. Science, Vol 111, No. 2890, pp. 546-548.

The ability of Coulter pine to survive long periods of drought on soils at or below the wilting point was investigated to determine the possibility of the plants taking up water from the atmosphere. A 2-year old Coulter pine seedling, growing in a sealed container to which no water had been added for 10 months, was sealed in a chamber which enclosed the vegetative portion of the plant and in which the initial humidity could be adjusted. Measurements with an Amico-Dunmore temperature-humidity sensing unit indicated a lowering of the humidity in the chamber from 98 to around 90 percent in 3 to 9 hours.

Evapo-Transpiration

\# The San Dimas Lysimeters, E. A. Colman and E. L. Hamilton. December 1947. Instruments for evaluating the water economy of chaparral vegetation. C.F.& R.E.S., Research Note No. 47. Part 1: the lysimeter installation and research program. Part 2: the relative performance of four types of lysimeters.

The San Dimas lysimeters were established for the purpose of comparing the water economy of a number of chaparral plant species that are important in the management of southern California mountain watersheds. The installation includes five types of lysimeters and a climatic station located on an area of uniform topography. The same kind of soil has been used and uniformly placed in all the lysimeters in order to minimize soil variability. Rain, run-off, and seepage are measured, and weighing or periodic soil moisture sampling is used to study evaporative water losses. Comparisons of the soil water cycle, annual evapo-transpiration values, and yield of annual grass have been made between four types of lysimeters which are included in the San Dimas lysimeter installation. These lysimeters exhibit differences in depth, size, surface drainage, and seepage conditions. Some have been maintained bare and some have supported stands of *Bromus mollis*.

Non-Staff Publications

Estimation of Water Supply Based on Rain Gage Distribution over a Watershed, George F. McEwen. 1934. Bull. Amer. Meteorol. Soc., Vol 15, No. 10, p. 235.

Investigations made possible by readings from a large number of rain gages distributed over watersheds in the San Dimas Experimental Forest are helping to answer the questions, how can we obtain the best estimate of the amount of water supplied to a watershed per storm or selected time interval? how reliable is such an estimate? The main factor influencing readings is altitude. There is in addition a large unavoidable, accidental variation.

Water for the Year 2000, Stuart O. Blythe. November 1936. California Magazine of Pacific Business. 26:11, pp. 20-23, 51-52.

An "outdoor laboratory" is described, dedicated to research on the subject of watershed management. The need for additional water supply in southern California and its integration with problems of flood and erosion control are discussed.

Fighting Fire and Flood with Science, Union Oil Bulletin. August 1938. 19:8. pp. 14-19.

The work of the U. S. Forest Service was facilitated by the personnel of the Civilian Conservation Corps. Enrollees were trained for fire fighting by the administrative branch of the Service, and aided in the construction and installation of experimental plots and equipment on the San Dimas Experimental Forest for the Research branch.

A Nomograph for the Integration of Stream Flow Records, Paul B. Johnson. October 1943. Civ. Eng. 13:10, pp. 494-495.

The conversion of streamflow rates to total volume of water for given periods of time was facilitated by a nomograph which also contained a means for the ready determination of the decimal point.

The Forest Floor of the Chaparral in San Gabriel Mountains, California, Joseph Kittredge Jr. April 1939. Jour. Agri. Res. 58:7, pp. 521-535.

The forest floor, or total accumulation of organic materials above the organic soil, has a certain importance in maintaining the productivity of the soil and in such water relations as evaporation, surface runoff, and infiltration. The volume of forest floor was sampled under various conditions and correlated with vegetation types, field moisture capacity, and water retention.

The Annual Accumulation and Creep of Litter and Other Surface Materials in the Chaparral of the San Gabriel Mountains, California, Joseph Kittredge Jr. April 1939. Jour. Agr. Res. 58:7, pp. 537-541.

Annual accumulation of litter accumulating beneath the chaparral on plots within the San Dimas Experimental Forest in southern California was sampled and related to vegetation types.

Some Quantitative Relations of Foliage in the Chaparral, Joseph Kittredge Jr. January 1945. Ecology. 26:1, pp. 70-73.

The dry weight of leaves on several species of chaparral vegetation was found to be related to crown diameters. This relationship is useful in studies involving interception of precipitation, solar radiation, and soil evaporation.